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ABSTRACT

This study explored secondary preservice science teachers' attempts to implement a constructivist approach to science teaching in a practicum setting. Described is the secondary science education program at St. Francis Xavier University. Interview excerpts are presented as data. Results indicated: (1) student teachers went through two developmental phases--reistant phase and experimentation phase; (2) students reported an institutional resistance to using a constructivist approach to science teaching; (3) the personal disposition of the student teacher together with institutional support appeared to be strong variables in influencing preservice teachers' acceptance of a constructivist approach; and (4) most of the students reported changing their view of teaching, but it was not supported in most cases in the practicum setting. The questionnaire on science teaching is appended. (YP)

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# "MAKING SENSE OF CONSTRUCTIVISM IN PRESERVICE: A CASE STUDY"

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Paper presented at the annual meeting of the National Association for Research in Science Teaching, Atlanta, Georgia, April, 1990

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## Introduction

Constructivist theory views the learner as one who actively "constructs" knowledge and meaning from their own experiences (Driver & Oldham, 1986). A variety of terms have been used to describe such constructions as alternative frameworks, prior knowledge, preconceptions, misconceptions and commonsense knowledge (Driver & Erickson, 1983). The focus of such research has been largely directed toward the study of children and is based on the premise that children's intuitive scientific concepts are learned from their everyday experience. This research has all taken place under one theoretical framework, constructivism (Driver & Oldham, 1986; Magoon, 1977). The findings of such research (Driver, 1981; Erickson, 1983) suggests that children's understanding of physical phenomena within the context of science instruction is influenced by their own physical and social worlds. While such studies have focused on students in the school system some have argued that this also applies to preservice teachers not only in their understanding of science concepts but also their views of science teaching and learning (Hewson & Hewson, 1985; Aguirre, Gurney, Linder & Haggerty, 1989). Aguirre & Haggerty (in press) report on a study of 74 secondary level preservice teachers enrolled in teacher education at the University of British Columbia supports this argument. Specifically they note in their paper:

> As with preconceptions of science, preconceptions of teaching and learning that conflict with more pedagogically appropriate notions may interfere with the student's teacher's propensity to personally construct the intended view of teaching, even when that view is the focus of instruction. (p.2)

Such comments suggest that even when appropriate instruction is provided it may be difficult for preservice teachers to abandon their original views of teaching and learning.

One process which has been described as useful in assisting preservice teachers to develop a constructivist approach to science teaching is reflection. By reflection I mean reflection-in-action and reflection-on-action. MacKinnon (1988,1989) in a study of preservice science teachers describes the role of reflection in constructivist science teaching. Specifically MacKinnon provided practicum data to





support three models of reflection (Follow Me, Joint Experimentation, and Hall of Mirrors) as proposed by Schön (1983, 1987).

This study therefore further explores secondary preservice science teachers attempts to implement a constructivist approach to science teaching in the practicum setting. This study of student teaching is a naturalistic study and as such evolved over the course of an academic year. The assumption of this study is that we can better understand what constructivist science teaching might look like by describing some aspects of the process that preservice teachers go through during their practicum. This paper will therefore focus on describing this process. This description may as a result give us some insight into such questions as:

1. What view of science teaching did the preservice teachers hold prior to the beginning of their program, and did this view change as a result of being exposed to a constructivist perspective?
2. What was the preservice teachers level of acceptance for a constructivist approach to science teaching?
3. How did the preservice teachers act out a constructivist approach to science teaching in the classroom setting?

## The Case Study

The sample included 10 subjects enrolled in the secondary science education program at St. Francis Xavier University, Nova Scotia, Canada. All of these students held at least a bachelor of science. These students were required to complete a one year course in science education and a ten week practicum experience as requirements for their bachelor of education.

The science education course consisted of two parts which corresponded approximately to the first and second semesters. The first half of the course was an exploration of the nature and philosophy of science education, learning theories and instructional strategies. The latter half was primarily a methods course which focused on the secondary science curriculum. During the first half of the course the students were introduced to the constructivist perspective.

The practicum experience consisted of ten weeks and was completed in three phases of four weeks, four weeks, and two weeks. A process that was used by the faculty adviser in the practicum setting was that of asking the student to reflect on their teaching experience.

This reflective process required the preservice teacher to analysis their classroom teaching. It was hoped that the preservice teacher's reflection on pupils' understanding of classroom experiences and subject matter would result in the preservice teacher suggesting new teaching strategies and activities for pupils.

The ultimate aim of the study was to use the data collected to describe the process that preservice teachers go through in the implementation of constructivist teaching strategies. The investigator's goal was to describe the process (analytical generalization) and not to enumerate frequencies (statistical generalization). This study therefore is only generalizable to theoretical propositions and not to populations or universes (Yin, 1984).

Multiple sources of evidence were used in this study. The specific data which was documented and analyzed included:

1. a questionnaire which was administered three times during the academic year (beginning, mid-point, and end), (see Appendix A);
2. audio tapes of interviews with preservice teachers at the end of the final practicum;
3. audio tapes of preservice teachers involved in large and small group instruction in practicum classroom settings;
4. audio tapes of an interview with a teacher adviser and representative students of one preservice teacher;
5. field notes on classroom observations of preservice teachers during the three practicum experiences (a total of ten weeks); and
6. other data sources, such as writings completed by the preservice teachers in their methods course, and student work samples collected by them during their practicum.

## Overview of Results

The St. Francis Xavier University preservice teachers' views of science, teaching and learning that were elicited on the questionnaire showed similar patterns to the U.B.C. data (Aguirre, Gurney, Linder, Haggerty, 1989; Aguirre & Haggerty, in press). The students entered the program with their own views and in some cases these views appeared to change in response to their science education program and practicum experience. I will use the data collected in this study to focus on the practicum experience in an attempt to illustrate the preservice teachers' response to a constructivist view of science teaching. In mapping out the progress of the novice teacher during the practicum experience the concern is with examining the factors which facilitate professional growth in the practicum setting. Therefore it is helpful to examine how preservice science teachers might respond to a constructivist view of science teaching.

This study has found that the preservice teachers responded to a constructivist approach to science teaching in the following manner:

1. First of all they resisted change which I shall call the **resistance phase**. This resistance is one of self-resistance to a new view of science teaching. Coupled with self-resistance the preservice teachers also referred to an institutional resistance to change.
2. The first phase is followed by a period where the preservice teacher tests out constructivist teaching strategies. This phase can be described as the **experimentation phase**.

The remaining part of this paper will therefore focus on describing these two phases. First, by providing an overview and then through the use of one preservice teacher's experience as a model of the process that preservice teachers in this study went through. The preservice teacher who will be used as an illustration is the one who was most successful at implementing a constructivist approach to science teaching.

## The Resistance to Change

The first phase which I would like to illustrate is what I have called the **resistance phase**. All preservice teachers during my final interview with them commented that they initially had difficulty accepting a constructivist view of learning. Although I had worked with these students for eight months prior to the final interview I was not sensitive to the fact that they had problems initially accepting a constructivist view. It was in response to a comment made by the first student I interviewed that I decided to ask all of the preservice teachers about this resistance. It is important to note that the final interview took place after the final grading in the methods course and practicum had occurred. The following excerpts are illustrative of their resistance to the acceptance of a constructivist view of learning that the preservice teachers shared with me at the end of the year. The first excerpt centers around a discussion of childrens' conceptions with a preservice teacher whom I shall call Judy.

Preservice Teacher: (Judy)

I: Why are you now interested in what the kids think?

J: Because you told us to (laughs). No, Mostly because what you have said this year but where it come for the most part is that you have made me realize. Especially when I stop and think about myself going into a class I know I have certain ideas and unless I really see the difference I don't think my ideas really change that much. You have pointed that out to us and I really believe it. **Kids really have certain ideas and unless I can show them the difference . It is like you are saying they might memorize it now and give it to me on a test. But three months from now, the digestive system, for example they are likely to give me the same thing as they gave me before we started. I think that is the main reason for my changes. I realize that now.**

I: Other than my saying that you should pay attention to childrens science what other basis do you have to make this change on?

J: O.K., **I think a lot of it would come to from what we as a class have said to one another outside what you said**. Most members in our science classes have had a lot of talks about we think has been working in our teaching and what hasn't and I think **most of us agree what seems to be working is the stuff that comes from the kids perspective, not from our own** ....

Here Judy talks about the need to be convinced about a new view of knowledge. Her convincing did not appear to come from the instructor and the literature but rather from her own experiences with students and her peers. It seems that discussions with her peers might have been critical in helping to convince her. Another preservice teacher also referred to peer discussions during my interview with her. One thing that she shared with me was that as a group they had often engaged in discussions which at the beginning of the year were often intense. According to another student teacher such discussions even resulted in a few tears being shed because of the disagreements over views of teaching.

Further illustration of the resistance to constructivism was shared by a student in a written comment at the end of the course when [redacted] asked to provide a criticism of constructivism.



**I will admit that in September I doubted this "children's science" and "constructivism" and failed to see how it would help make us better science teachers; now I see differently**. So, I'll try to evaluate the constructivist approach from my point of view as clearly as I can, and illustrate what I believe are its most relevant and helpful factors for science teaching.

There was however one student teacher during the final interview who did not admit to resisting a constructivist view.

Preservice Teacher: (Peter)

I: When you were first introduced to a constructivist approach to science teaching did you resist this approach.

P: **No, I don't think so.**

I: You didn't go through any period of rejection or anything like that?

P: Let me think you are talking way back in September, right?

I: Yes.

P: Eh, **no I don't think so cause I didn't have any idealist views** of the way things were any way.

Peter appears to have been more open to a new view of teaching. This seems to suggest that there may be some student teachers who may not go through a period of resistance. However based on the students I work with in this study such students appear to rare.

Although as an instructor I can recall no specific dialogue that took place during class discussions that would have made me more sensitive to the fact that most of the students were having difficulty accepting a constructivist view. Given the "performance for grades" which occurs in most university courses it was very unlikely for a student to take such a risk. There was however lots of indication from the practicum setting in that the students were not implementing constructivist strategies in their teaching. When I would discuss this with them during the post conference they would always say that this is not the way that their teacher adviser taught and that they were modelling after the adviser, this is not the way science is taught in this school, or I have to cover the curriculum. In most cases they would always point out that things would be different in their own classroom. The institutional resistance may not have been as strong however as the students led me to believe. It is no doubt that the students did

experience some institutional resistance. This institutional resistance should be explored further in future studies.

## One Preservice Teacher's Practicum Experience

By describing one preservice teacher's experience I will attempt to describe the developmental process she went through in implementing constructivist teaching strategies in her classroom. This description is based on interviews with the preservice teacher, her teacher advisor, and four of her students. The preservice teacher shall be referred to as Gail. At twenty-three years of age Gail had completed a Bachelor of Science, with a major in biology and a minor in philosophy. Her teaching assignment for the practicum consisted of grades 10 and 12 biology.

The teacher adviser, Tom, was a 19 year veteran at the time of this study. He was well known and respected among his colleagues. He was actively involved in his own professional development both at the district and provincial levels. He did some inservice work in the area of environmental education and on one occasion during the school year did a workshop with all the students in the teacher education program. Based on informal conversations I had with some of his students he was often described as "the best teacher".

Gail's first practicum experience consisted mainly of learning the classroom routines. She basically took a very structured approach and presented the material as outlined in the text. During my first school visit with her she presented a time table to me where she had planned to take over 100% of the teaching load before the end of the first practicum. Her idea at that time was that through total immersion she would speed up the process of learning how to teach. She was quite disappointed when I asked her to cut back the teaching load to the recommended teaching load of approximately 30%.

During my early conversations with Gail she emphasized that she wanted to be a good teacher. Her concept of how to become a good teacher at that time was to model after the best university professor that she had. She noted that she had a lot of professors whose teaching was poor and that she didn't want to be like them. Her view of good teaching strategies at that time was being able to do a good presentation. That is, she saw teaching as the dispensing of knowledge. Her view was that how successful you were at teaching depended upon how well you could present the information to the students. Gail like the other students in this study went through a





**resistance phase**. Her resistance is highlighted in the following conversation with her where she discusses her early view of scientific knowledge,and the change that had taken place in that view:

> G: My view of scientific knowledge in September was, eh, I think I was probably proud of it was, eh **lots of information, lots of facts, I like knowing things in the simple way, the simple form of systems or situations so that. That was part of the reason why I was comfortable with the lecture method in September** and the reason why I found school and biology easy and fun when I was in high school because I find it very easy to, learn facts and data if I find it at all interesting. Biology, I like knowing stuff about biology, for example. **My whole idea of knowledge in biology was, eh having lots of information, lots of facts, and eh to be a teacher would be to pass on that information to the kids**. Say look isn't this exciting, or this is really interesting, learn about this. Eh, but it is not a thing that my minor in philosophy helped me to understand. There is a whole other way of learning, a whole other way of knowing. Being presented with information and making a judgement on it because one of the most shocking things that ever happened to me was to have my philosophy prof in my third year of university, walk in spend the first three days of the week building up an argument, setting up a situation so that when he was finished I believed that such and such were true, and then on the fourth day he came in and blew it all apart, with counter arguments. That was the first time I ever been presented with anything like that because science was always presentation of absolute truth, to be accepted without question, and to be memorized, and so that is something I want to get away from. **There is still information, the information part of it is important I am not saying that it is not but it is only a basis by which the kids learn how to make their own inferences, to build their own connections, to create their own framework which they can see the world, not necessarily going to be the same as my framework. It is going to start with the same information but hopefully I will give them what is needed to make decisions as well as the freedom to make decisions. It is going to take awhile because I have to do my own change around, a phase shift or something. What I was coming**

**from before, my system before was very different, and trying to make room for thinking and trying to open up for broader ideas of what knowledge is all about is going to take some time.**

Now at the end of her practicum experience Gail recognized that her view of scientific knowledge had moved from a positivist view of knowledge towards what she describes as a "broader view". Her view of knowledge is further illustrated in the following excerpt:

G: **I am growing towards a broader view, but I am still, I still have strong ties to the positivist tradition, yeah because that is what I have been working with for this last twenty years. So I have got to use that as a base now. I am not going to junk it all.** I am not going thro[illegible] it all out but I am going to say this is the base I can start making some changes, hopefully to generate a lot of new ideas.

Again she restated that she had not abandoned completely her original view. What was significant in both of her responses was that she recognized that it will take time to change.

Shortly after the first practicum Gail visited me at my office to convey her frustrations about the role of reflection during our post conferences. She did not see any point in reflection she wanted to be told what she had to do and that I was to tell her what she was doing wrong. I tried to inform her of the role of reflection but I do not think I was successful at that time. During my final interview with her we discussed her resistance to changing her view of knowledge.

G: Yes, I resisted it. I definitely because it is not, it is not easy to change. I don't like change. **Change is not a safe as, as not changing. Now you can rationalize and say that eh, change is generative, change is necessary in order to avoid stagnation, in order to avoid becoming bored and that all kind of stuff, and change is necessary for growth.** But I didn't like growing up when I was twelve. I didn't like. I loved being a kid I didn't want to become an adult. I didn't like to change and I still will balk at changes. **I has got to be a decision to, I got to weight the cost and benefits. Yes, if the benefits are worth the change and so in that case there is a little bit of resistance but I will come around if I think it is worth while.** But I recognize that something about myself is that I do resist change, quite strongly.



This conversation highlights some of Gail's earlier resistance to changing her view of knowledge. But what this seems to illustrate is that a preservice teacher has to be convinced of the benefits in order to make such a change in their view. At a later point in the conversation we then went on to explore if she saw a relationship between change and reflection:

G: Yes, you can't, if the change is going to be generative, if you're going to. **Whole purpose of reflecting on your own work is to, or even to reflect on a situation is to come to some decision about it, hopefully in order to build on it.** You reflect on, I mean an architect is going to work on past designs hopefully to come up with new ideas. As a teacher you would reflect on the strategies you have used and the success rate that you have had with these strategies and then you say alright given the kids reaction to such and such, and given the way I presented it, or the way I worked with the kids is there a better way and if there is a better way am I prepared to change and try that better way. Trying something different is going to be risky but the only option is to wither up and die. You are going to bore yourself to tears if you never change. **I would say that reflection is necessary for change if it is going to healthy change and that reflection is meaningless if you are not prepared to change. There is no sense in criticizing your own work or considering other peoples work, other peoples strategies or attitudes if you are not prepared to accept a better one and change to a better one . . . .**

It appears that Gail felt that reflection should automatically result in change. Since a novice teacher has some special problems with reflection it was necessary to explore this further with Gail:

G: **For a novice, reflection is difficult I think because you don't know what to compare with, like you don't have your own experience to compare with . . . . I am still not part of the community yet. I am working at it but I don't pay attention to everything. I don't see everything because I still tend to** be drawn into and focus too long on certain things. I can

**even get side tracked by things that might not even be important. I think that for me to have useful reflection on my own experience I have to. I have to draw on someone else's experience they have to point out what is important and what is not important because the things that I get very concerned about might not be important, as well the things that I pass off and don't give any credence to might be significant. The initial feedback is important especially in the first couple of weeks. I need somebody else to point out what is the norm in this little community because it is like entering. It is like being an anthropologist, is it? In a new community and not knowing what the norms are, . . . . You don't know what's important and what's insignificant. Everything is hitting you at once so it takes awhile to pull those things out and you only want to focus on the important things.**

Gail is not untypical of most novice teachers I suspect in that she initially found reflection difficult. This conversation with Gail emphasizes that some how the preservice teacher has to acquire the norms of the teaching community before they are successful with reflection. The teacher and faculty advisers therefore play an instrumental role in helping preservice teachers acquire these norms before reflection can be meaningful to them. This also helps to explain Gail's frustrations with our attempts at reflection during the first practicum. As a faculty adviser who only meet with her on a weekly basis I was certainly unable to provide her with the norms to the extent that her teacher adviser was able.

Gail's second practicum experience occurred about halfway through the teacher education program. Up to that point the preservice teachers had undergone extensive discussions of constructivism, read numerous articles, explored constructivist teaching strategies. During this stage of the practicum experience Gail began to experiment with new teaching strategies and at that point she entered the experimentation phase. She was also relaxed enough to get a feel for her teacher adviser's approach to teaching. It was the final practicum experience however which showed the most dramatic shift in her teaching strategies. Here Gail's creativity showed. She organized a stations approach to a study of marine biology. She encouraged the students through group work to make explicit their own understanding of marine fauna and flora and to explore further the biological descriptions for the specimens. She provided the students with a wide variety of printed and hands-on materials.

I meet with four of Gail's students at the end of the practicum. During this conversation they responded to her teaching of the marine biology unit in the following manner:

S2: **I liked what she did with the, the study of marine biology. She had us study a number of marine specimens.**
S1: Took two weeks.
I: Probably you should comment on what you like about the unit on marine biology?
S4: **It was the way she taught it, instead of tell us how something is you are learning it yourself, like she, you glance impressions and you found out the answers. It was finer that way instead of having to sit there and watch her and write stuff down.**

Based on this brief except we form a view that the students responded to her teaching in a positive manner. Beyond a description of how they felt I pursued a description of Gail's teaching strategies from the students' perspective:

S1: **She eh, she was kind of different like. She wasn't one who'd write all your lessons on the board and that she'd show you filmstrips or make it a little more interesting talking about her experiences.**
S2: **I think the way she did it. Keep you more interested.**
S1: Trying
S2: **Keep you from slipping out of class at the very end like copying notes from the board. You had to pay attention in her class.**
S3: **She use to pass out pictures and all that stuff for us to look at too.**
S1: **The labs, she helped us with the labs a lot.**
S2: Yes.
S3: **She was easy to eh, she had a lot of stuff available for everyone else in the class. She was easy to get along with in the lab.**
S1: **She didn't make you feel,feel stupid if you asked her a question. Look at you like, like you know.**
(students laugh)

I: How do you make a student feel stupid when they ask a question?

S1: They just give you a look. Give you a weird look or something, just, or say the answer sarcastically.

S2: She makes you feel comfortable.

S3: **You are not nervous to ask her a question cause you know she is going to stand there beside you and lay it out for you the simplest way that she can.**

I: Was she looking for the right answer?

S4: **No, she was looking for your answer. She'd help you along.**

I: Was she interested in what you were thinking?

S1: Yes she was.

S2: **She liked to have the class get their say in. She liked to hear what the class had to say. She'd give her view then she'd give the class an opportunity to give their view on what's going on in the class and what's she is teaching at the time.**

This excerpt illustrates one of the basic tenants of constructivist teaching strategies in that her focus was on having students reveal their own ideas about a scientific concept. When the students brought out that Gail was interested in student views I then explored this further:

I: Your own ideas how much did she use that in her teaching?

S1: **Well if you gave an answer she would say well let's look at that, that way and she would talk about it and if it was wrong then.**

S4: **She would show how it is wrong.**

S1: **And yeah, and then yeah, then she start on and if someone else had something to say she would just give the way it was suppose to be.**

S2: **She kind of felt that the opinion of the student was the most important part of the class because you are not really, really getting your point across, just standing there in front of a bunch blank eyes. Just talking away but making your students, getting the student involved. One or two students kind of brought everyone, everyone kind of jumped on, tried to get involved and made it more interesting, easier to pay attention. I think she covered**





**that aspect she felt it was pretty important to have the students involved in every class.**

Here again the students were quite articulate in outlining Gail's use of questioning as a teaching strategy for revealing student ideas about science concepts.

Gail had been encouraged in her science education course to take a constructivist perspective in her teaching. Her teacher adviser also had a dramatic influence on her teaching. During an interview with Gail and Tom at the end of the practicum he describes what he hoped she would learn about students:

T: First of all I want to point out that her relationship with students is very good, better than a lot of teachers that have been teaching for years. She has a, she doesn't put on any, there is no facade. She is what she is and she presents herself that way. The kids know that so there is no disguise. If she doesn't understand something or she tells them that. **What she is picking up from students is an appreciation for their differences. That each kid is totally different from somebody else. The last class she had everybody in that class works at their own pace, and everybody is just slightly different. Some kids have their idiosyncrasies and others do not and she is learning to handle that very nicely. . . . . She is very empathic towards them** she appreciates them and they in turn appreciate her.

Based on such comments her adviser's view of teaching is obviously student centered. This response was followed up by exploring his views on how to achieve a student centered approach to science teaching:

T: **At the beginning of the year it was a type of question and answer. Asking a question and then sometimes giving an answer. What has developed and I can see it now is. I has developed this way, asking a question and not giving necessarily the answer but allowing them to pursue their answers, as she did in the marine biology unit.** I think what she has managed to do, and a lot of science teachers would love to do it. Have the kids think for themselves, every once and a while here the answer but I think what

> we all try to do in science and in teaching in general is to ask the kids a question and let them reflect on it, think about it and try to assimilate a fairly decent answer. Whether it is right or wrong that doesn't matter. I think what Gail is doing that she has a long way to go, I don't think she has mastered it quite yet but I don't think any of us have. At the same time she has allowed the students to think. The critical thinking is on its way it is coming. . . .

When discussing the relationship between student teacher and teacher adviser Tom talked about passing onto the student more than just strategies for teaching but a love for teaching and that it is a worthwhile career. This allowed for an exploration of how this might be done:

> T: I think if you enjoy teaching, if you enjoy anything, I think it is reflective. I mean it comes off as being. I enjoy it hopefully you enjoy it and you encourage them to work and develop along those lines. I don't think teaching is for everybody, as you can see what happens some times in the program which is a shame. I think if you are willing to work with it. Stick with the program, even though you have flaws all the way through. People got flaws, I got flaws we have all got flaws in teaching strategies but hopefully working together with somebody. The mere fact that she taught classes this year I have learnt from her and she has learnt from me. The kids have learnt from both of us and we have learnt from the kids. I have used strategies that she has used that I never even thought of you know and she has too.

Gail's teacher adviser's view of learning to teach is reflective process where both the adviser and the student share and analyze teaching experiences. Such a response allowed for a discussion of her adviser's ideas on how the reflective process might work:

> T: I want the student teacher to get an appreciation of what teaching is about. Let's face it is one of the most important professions there is. People disagree but I believe it is an important profession and as a result I think you are not coaching them, it is not a show and tell, you are not putting on acrobats, not acting anything out you are doing what you feel is encouraging those kids to learn. As a result when you project yourself across to the classroom, if you project yourself, loving what you are doing then automatically it is reflected what the student teacher is going to do. If I stood up there and read out of the book all day long then that tells me I am bored silly with my job. Why do I have a student teacher. Why do I even bother teaching. I can't say you put yourself into any one category. You are not in a category, you are a whole spectrum of things.

It is obvious from his comments that what he hoped for Gail to learn about teaching can be described as a constructivist view. Since Gail's teacher adviser had evolved this view of teaching mainly based on his teaching experience then I would label him as "a natural constructivist". I would describe him as natural constructivist on the basis that there was no dialogue between the university and the teacher adviser about constructivism. Gail therefore had the support of her teacher adviser during her practicum. The school she worked in may have played some role in influencing her teaching. The school however I believe played a very minor role since four of other preservice teachers in this study also worked within the same school. Most significant point appears to be the fact that the other students I supervised during the practicum did receive the same level support for constructivist teaching from their teacher adviser. This may partially explain why Gail was more successful than her colleagues in implementing a constructivist approach to science teaching.

When asked to provide a written critical review of constructivism Gail responded in the following manner.

> In conclusion I would say that the main criticisms of constructivism - that is too idealistic, unrealistic, and definitely more expensive (due to teaching aids, field trips, etc.) - are cop-outs.
>
> That it is more difficult is not adequate justification for not trying it.
>
> Education is a journey and whether you are a teacher or a student (and we are all students of a sort) you carry your own particular baggage when you begin. You pick up new things along the way, throw some things out and keep others. The destination is unknown and, I would argue, not reached in this lifetime.

Here Gail metaphorically describes the teaching-learning process as a journey. This metaphor presents a rich view of the teaching-learning process which can be described as constructivist. This is quite a contrast to her original transmissive view. Such a statement may suggest that Gail may be moving from the **experimentation phase** to an **adoption phase**. Since this study did not go beyond the preservice level then exploration of the adoption phase would have to be undertaken in a follow up or longitudinal study. Given that Gail was the student who most successfully implemented a constructivist approach to science teaching then may be some students such as Gail have a natural disposition or intellectual curiosity which allows for such a change. Such students are likely to have self-confidence and be risk takers. These are two attributes that Gail appeared to possess. Beyond any natural disposition that Gail might have had she also had institutional support at the school level from her teacher adviser. The other preservice teachers did not have the same level of institutional support that she had.

## Discussion and Conclusions

The results of this study can be summarized as follows:

1. In their attempts to implement a constructivist approach to science teaching most of the student teachers went through a number of developmental phases. Two phases were identified is this study. The first phase is one of self-resistance. The second phase is experimentation. It is also predicted that there may be an adoption phase. However further longitudinal studies are necessary to examine this.
2. Most of the students reported an institutional resistance to using a constructivist approach to science teaching.
3. The personal disposition of the student together with institutional support appear to be strong factors in influencing preservice teachers acceptance of a constructivist approach.
4. Most of the students on the basis of the questionnaire appeared to change their view of teaching. This change however was only on paper and was not support in most cases in the practicum setting.



The preservice teachers I worked with entered the program with mostly a transmissive view of science teaching. Just as those researchers who worked with children found a resistance to change this study also found that the preservice teachers resisted a change in their view of teaching. All of the preservice teachers in this study except one described themselves as going through a period of resistance. Factors which appeared to have most influenced them to go beyond this resistance phase were their peers and their experiences with the students during the practicum. The university instruction may have had some influence but it was their peers and their practicum teaching experience which was the most convincing. Based on the ten preservice teachers in this study the change in their view of teaching was however largely on paper and it did not often translate into action in the classroom setting. Although most students attempted some experimentation with the constructivist approach. This experimentation was mostly superficial except in the case of one preservice teacher.

The preservice teachers reported a institutional resistance to the implementation of constructivist strategies in the practicum setting. This institutional resistance may have handicapped some students or it may have provided them with an excuse for not implementing constructivist strategies. On the other hand the results of this study suggest that preservice teachers need institutional support from both their faculty and teacher advisers if they are to successfully undergo a change in their view of the teaching-learning process. Based on the practicum experiences of ten preservice teachers it appears that the teacher adviser possiblely plays the greatest institutional role. The university course and the faculty adviser although presenting a constructivist perspective seemed to have a minor influence on the student when compared to the teacher adviser.

The personal disposition of the preservice teacher may also be a critical factor. If the constructivist preservice teacher in this study is typical there appears to be personal attributes such as self-confidence and risk taking which may influence change. These personal attributes of the preservice teacher coupled with institutional support appeared to present for the preservice teacher who reached the experimentation phase of implementing a constructivist approach to science teaching.

In conclusion both personal disposition of the preservice teacher and institution factors appear to play a significant role in the professional development of preservice teachers. The question that this raises is what is the significant impact of these factors? Certainly at the preservice level the student teacher is very reluctant to challenge their teacher adviser's view of teaching and may very well

be able to implement a constructivist approach in their own classroom. A longitudinal study of such preservice teachers might reveal insights into as to whether they would actually implement constructivist teaching strategies in their own classroom. Again preservice teachers might claim as the majority did in this study that there were also institutional constraints once they had their own classroom. Another worthwhile question is, would students such as Gail adopt such a constructivist approach in their own classroom? Such a question has resulted in the conjecturing of the possibly a third phase called the adoption phase. Such a conjecture needs to be explored beyond the preservice level. Like most exploratory studies this study has therefore raised more questions than it has answered.



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## APPENDIX A

The following items were included in the questionnaire, which was developed by the [SI]$^2$: Students' Intuitions and Science Instruction project, Mathematics and Science Education, University of British Columbia.

### QUESTIONNAIRE ON SCIENCE TEACHING

Respond briefly the following questions:

1. What does the word **science** mean to you?
2. How do you think scientific knowledge has been produced?
3. What are people who do science trying to do?
4. Do you think that the scientific method is the only way to do science? Why do you think so?
5. Why do you want to become a science teacher?
6. What are some teaching strategies that you consider to be most effective for teaching science to secondary students? Underline those that you think are most important.
7. Would you teach novice students, (i.e those who are encountering formal science for the first time) any differently? If so, how?
8. Some people have suggested that many students develop their own "theories" to explain nature, and sometimes these theories can be substantially different from the so-called scientific theories. What do you think about this suggestion?
9. How would you consider the students' own theories in your teaching if at all?
10. Give your own **metaphor** for the teaching/learning process?
11. If you can, briefly describe your own "theory" about how learning occurs.